and has been already adopted in at least one outdoor school of natural history.

The objections to the method arising from the possibility of danger to the young thus removed from the site selected by the parent are carefully discussed by Professor Herrick. It is well, however, to repeat his warning against interfering lightly in the home life of wild birds. In the opinion of the present writer, none but trained naturalists should use the method, for they, if animated by Professor Herrick's genuine love for the individual bird, will be on their guard against the dangers likely to be incurred.

R. H.

The Fishes of Ohio is the title of a paper by Professor Raymond C. Osburn, published as a *Bulletin of the Ohio State University* (Ser. 5, No. 20). The paper is a descriptive faunal list of the fishes known to occur within the borders of the state. In the Introduction is given an historical sketch of ichthyological investigation of Ohio fishes.

Each species is briefly, though sufficiently, described; following each description is a list of localities in the state where the species is known to occur; there is also given a few notes concerning its habits, etc. Keys to facilitate identifications are also given. The paper is neatly and carefully gotten up and indicates very careful and thorough work.

The publication of descriptive faunal lists like the present one, by institutions which have the facilities for such work, is to be highly commended.

In a footnote *Notropis fretensis* (Cope) is regarded by Mr. Osburn as being allied to *Notropis heterodon* Cope and *Notropis cayuga* Meek, a belief shared by Drs. Jordan and Evermann. It is, however, a *Notropis rubrifrons* (Cope), differing from the typical *rubrifrons* in having but eight anal rays. In his original description Professor Cope calls attention to the fact that this species resembled *Minnilus*. *Notropis rubrifrons* usually has ten anal rays. It is not, however, uncommon to find some specimens with nine or even eight anal rays.

The type of *Notropis rubrifrons* is in the Philadelphia Academy of Sciences, where I had the pleasure of examining it a few years ago.

S. E. Meek.

The Otocysts of Decapod Crustaceans. — An exhaustive study of the structure, development, and function of the otocysts of decapods

has been made by C. W. Prentiss.[1] In Palæmonetes, as in most other macrurans, the otocyst is a sac lodged in the basal segment of the antennule and opening dorsally by a constricted aperture partly covered by a scale-like fold. The sac is lined with cuticula which at the aperture is continuous with the animal's external shell. On an elevation rising from the floor of the sac is a horseshoe-shaped double row of from forty-five to fifty-eight hairs. The hairs are plumed and instead of being straight, as the tactile hairs of the outer surface are, they are bent so that the distal part of each shaft makes an angle of 120 degrees with its shorter base. Each hair is attached to the sac by a thin-walled chitinous bulb, thus allowing the hair as a whole to move freely. In the tangle formed by the crossing of the hairs are lodged fine grains of sand and organic detritus constituting an otolith. Every hair has at its base a group of matrix cells by which its chitinous wall was secreted. A single nerve fibre leads from the base of the hair inward to the brain, where it terminates in many fine branches. Each fibre has on its course a single cell body, so that each "auditory" hair is innervated by a single neurone. The same is true of the tactile hairs of the general surface, but the olfactory hairs, on the contrary, are innervated each by as many as a hundred neurones. Not only do olfactory and tactile hairs differ in this respect, but they can also be distinguished by the fact that in the olfactory hair the nerve fibres pass far out through the axis of the hair towards its tip, but in the tactile hair the single fibre ends at the base of the hair. An otocyst essentially similar to that in Palæmonetes was found in Crangon and in Cambarus.

In the common green crab, Carcinus, the otocyst is closed, contains no otolith, and its hairs are arranged in three groups instead of one. The innervation of these hairs is the same as in the macrurans studied.

Every time a shrimp or crab casts its shell, the cuticular lining of the otocyst, the attached hairs, and the otolith, if such be present, are discharged. As a preparatory step to this change, the matrix cells form a new hair under each old one, the new hair being half inverted in that the tip is pushed back into the base as the end of a finger of a glove might be infolded into the rest of the finger. When the skin is shed the new hairs are in part drawn out by the retreating skin to which they are slightly attached and in part

[1] Prentiss, C. W. The Otocyst of Decapod Crustacea: its Structure, Development, and Function, *Bull. Mus. Comp. Zoöl.*, vol. xxxvi (1901), pp. 167–251. 10 pls.

expanded by blood pressure. The discharge of the contents of the otocyst is through the natural aperture of the cyst, which remains open in macrurans but rapidly closes in brachyurans. Where an otolith is discharged, as in the shrimp and other macrurans, the animal immediately after ecdysis gathers in its claws small sand grains and puts them in the opening of the otocyst. These become attached to one another and to the auditory hairs by secretions from the walls of the otocyst and thus form a new otolith.

The otocyst was originally described as an organ of hearing. When sounds are produced under the water of an aquarium in which shrimps are contained, the animals respond by a darting movement if near the source of sound. The vibrations which stimulate the shrimps, however, can be *felt* by the submerged hand at a distance of ten to twenty centimeters greater than that at which the shrimps react. Moreover, shrimps respond to these vibrations even after the otocysts are removed. The reactions are inhibited, however, by the removal of the antennæ and antennules with their tactile hairs. It follows from these observations that whether we call the reactions auditory or tactile, the otocysts take little or no part in producing them.

If, then, the otocysts are not stimulated by sound, what is their function? When the otocysts are removed, shrimps swim with a more or less rolling motion and may even turn ventral side up. Their equilibration is thus shown to be seriously interfered with. When their eyes are covered with opaque materials so as to blind them, they swim with little or no rolling motion; but when both blinded and deprived of otocysts, they move with the greatest irregularity, swimming sometimes on their backs and sometimes in irregular spirals. Their capacity for orientation has disappeared completely, and as the experiments show, though the eye plays some part in keeping the animals upright, the otocyst is the chief sense organ in originating orientation reflexes. The otocyst is stimulated through the pressure of the otolith on the sensory hairs, as is shown by the ingenious experiments of Kreidl, who induced shrimp to form otoliths of iron particles instead of sand grains and then found that the animals became oriented to the lines of force of a magnet as they formerly did to gravity. These results are confirmed by Prentiss.

The development of the otocyst is also dealt with. It is not present in the first larval stage of the lobster nor is it more than indicated in the second and third, but at the fourth stage it suddenly appears with almost the full complexity of its adult structure. The locomotion of

the animals shows a corresponding change; young lobsters swim with great irregularity until the otocyst is developed, after which they regularly assume the upright position. It is also interesting to observe that immature lobsters newly molted and not allowed to form a new otolith reassume the rolling movements of their earlier stages and continue in these until opportunity is given them to form new otoliths. Thus the results obtained by Prentiss confirm completely the view first advanced by Delage, namely, that the otocyst has as its chief function that of originating orientation reflexes. That it is not an organ of hearing cannot with so much certainty be maintained, although its importance in this respect has assuredly been shown to be very slight.

P.

Recent Work on Anopheles. — In a recent study on the geographical distribution of Anopheles in relation to the former distribution of ague in England, G. H. F. Nuttall records with L. Cobbett and G. Strangeways (*Journal of Hygiene*, Vol. I, January, 1901) a series of observations of general interest in addition to much that is purely medical. He finds that three species, *Anopheles maculipennis*, *A. bifurcatus*, and *A. nigripes*, occur in Great Britain in all districts formerly malarious, but extend into regions in which no ague is known to have been prevalent at any time. To-day Anopheles is most numerous in low-lying land containing stagnant or slow-flowing water and corresponding to the districts where ague was formerly prevalent. As the disappearance of this disease does not depend upon the extinction of Anopheles, possible causes, therefore, are: (*a*) a reduction in the number of these insects consequent upon drainage of the land; (*b*) a reduction of the population in infected districts by emigration; (*c*) the use of quinine; or (*d*) the extinction of another yet unknown intermediary host besides man capable of harboring the parasite. The coincidence of the geographical distribution of ague and Anopheles is certainly not as precise as claimed by Grassi, and probably the *numerical* distribution will prove of equal importance. The presence of Anopheles in non-malarious districts explains the occasional occurrence of ague if a malarious subject comes in from other parts.

In another paper on the structure and biology of Anopheles, Nuttall and Shipley (*Journal of Hygiene*, Vol. I, January, 1901) give a full summary of our knowledge, together with personal observations. Noteworthy is the fact that the larva of Anopheles, as also that of Dixa, browse upon matter adhering to the surface film, like